National Institute of Environmental Health Sciences

Meteorologically conditioned time-series predictions of West Nile virus vector mosquitoes

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Abstract:

An empirical model to forecast West Nile virus mosquito vector populations is developed using time series analysis techniques. Specifically, multivariate seasonal autoregressive integrated moving average (SARIMA) models were developed for Aedes vexans and the combined group of Culex pipiens and Culex restuans in Erie County, New York. Weekly mosquito collections data were obtained for the four mosquito seasons from 2002 to 2005 from the Erie County Department of Health, Vector and Pest Control Program. Climate variables were tested for significance with cross-correlation analysis. Minimum temperature (T(min)), maximum temperature (T(max)), average temperature (T(ave)), precipitation (P), relative humidity (R(H)), and evapotranspiration (ET) were acquired from the Northeast Regional Climate Center (NRCC) at Cornell University. Weekly averages or sums of climate variables were calculated from the daily data. Other climate indexes were calculated and were tested for significance with the mosquito population data, including cooling degree days base 60 degrees (C(DD-60)), cooling degree days base 63 (C(DD-63)), cooling degree days base 65 (C(DD-65)), a ponding index (I(p)), and an interactive C(DD-65)-precipitation variable (CDD-65 X P(week_4)). Ae. vexans were adequately modeled with a (2,1,1)(1,1,0)(52) SARIMA model. The combined group of Cidex pipiens-restuans were modeled with a (0,1,10,1052 SARIMA model. The most significant meteorological variables for forecasting Aedes vexans abundance was the interactive C(DD-65) X P(week-4) variable at a lag of two weeks, E(T) X E(T) at a lag of five weeks, and C(DD-65) X C(DD-65) at a lag of seven weeks. The most significant predictive variables for the grouped Culex pipiens-restuans were C(DD-63) X C(DD-63) at a lag of zero weeks, C(DD-63) at a lag of eight weeks, and the cumulative maximum ponding index (I(Pcum)) at a lag of zero weeks.

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Resource Description

Early Warning System:

resource focus on systems used to warn populations of high temperatures, extreme weather, or other elements of climate change to prevent harm to health

A focus of content

Exposure :

weather or climate related pathway by which climate change affects health

Ecosystem Changes, Meteorological Factors, Precipitation, Temperature, Other Exposure

Temperature: Fluctuations

Other Exposure: evapotranspiration

Geographic Feature: ☒

resource focuses on specific type of geography

None or Unspecified

Geographic Location: ☒

resource focuses on specific location

United States

Health Impact: ☒

specification of health effect or disease related to climate change exposure

Infectious Disease

Infectious Disease: Vectorborne Disease

Vectorborne Disease: Mosquito-borne Disease

Mosquito-borne Disease: West Nile Virus

Mitigation/Adaptation: ☒

mitigation or adaptation strategy is a focus of resource

Adaptation

Model/Methodology: ☒

type of model used or methodology development is a focus of resource

Exposure Change Prediction

Resource Type: ☒

format or standard characteristic of resource

Research Article

Timescale: ☒

time period studied

Short-Term (

Vulnerability/Impact Assessment: ☒

resource focus on process of identifying, quantifying, and prioritizing vulnerabilities in a system

A focus of content